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# The scenario of a possible impact event of the Cretaceous-Paleogene boundary based on the "orbital" hypothesis*

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**Abstract.** The studying the regions of global seismic belts, to which giant impact structures belong, confirms the hypothesis of the possible attachment to the Earth of its satellite at the Cretaceous–Paleogene boundary and the coincidence of these belts and structures to the routes of its tangent flight along the Med–Eocene position of the equator.

**Keywords:** Catalogs and databases of the impact structures, orbital motion, global tectonics

## Introduction

In [1], a cosmogenic "orbital" model was proposed that explains the location periodicity of the unnaturally smooth furrows and surfaces on the Earth, of the volcanic zones, the valleys of civilizations, the zones of mineral extraction and of much more by the repeated tangential impact of a large cosmic body (CB) captured by the Earth as a satellite and made several dozens of turns of the tangential motion around the planet before falling and sinking into the Earths bowels. A similar model of the capturing and attaching to the Earth a satellite comparable in size to the Moon has been repeatedly used in the world literature [2,3] to explain new data about our planet past obtained by science. For example, the scenario for bombarding the Earth at an early stage of its development by a small number of large protoplanetary bodies comparable in size to the Moon calculated using a supercomputer [3] shows that such a scenario is quite feasible, and unlike small asteroids, the protoplanets will not fall to the Earth's surface immediately. After approaching the Earth-Moon system, they must remain in its orbit for tens of thousands of years, getting closer and closer to the Earth. This model explains not only the occurrence of depositing the gold, platinum and other precious and heavy metals on the Earth's surface, but also does the inclined position of the Moon's orbit plane with respect to the ecliptic [3].

In the "orbital" route calculation method developed by F.R. Hazivaliev [4], the initial parameters of the assumed tangential motion of the CB 800 km in diameter along the Earth's surface: the first contact point and

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the direction of the circum navigation routes were chosen from the consideration of maximum compliance of the obtained routes with the cosmogenic impact "traces" observed on the Earth. In particular, with a direction of 68.7° relative to the equator, the obtained routes coincided well with the largest hydrocarbon mining sites [4], the world deposits of which, according to academician V.B. Porfiriev, "were formed simultaneously in the Miocene–Quaternary time (during the last 13–10 million years) due to the opening of deep fault zones, along which the liquid and gaseous hydrocarbons rushed into the sedimentary layers of upper lithosphere spheres from its source which was in the mantle area" [5].

In the current paper, we will apply this technique to the proposed event [2] at the end of the Cretaceous period (at the turn of the Cretaceous-Paleogene 65 million years ago) — to the joining to the Earth of the Perun satellite (with an initial radius of 2,938 km [6]). In this case, the choice of initial parameters turns out to be more definite. According to theoretical conclusions [6], in the process of approaching the Perun and the Earth, the interaction forces would determine the location of their equators in a single plane, therefore, the point of initial contact should be in the area of the Earth's equator, and the direction of CB approach should be along the equator line.

## 1. On the equator position at the Cretaceous-Paleogene epoch

According to paleomagnetic reconstructions (for example, [6, 7]), significant movements of the continents and poles (and, accordingly, the equator) occurred throughout the Earth's history. For example, according to [6, 8] in the Eocene–Oligocene (40–50 million years ago), the equator was located where the Alpine folding was formed (the Alps, the Caucasus, the Atlas, etc.). In addition, in the interval between the Cretaceous and the Eocene, the paleomagnetic data record a sharp change in the pole migration direction towards its current position [6]. It is possible that the pole motion jump and the processes of the last major tectogenesis were the result of the addition to the Earth of a huge satellite mass (constituting 6.4 % of the modern Earths mass) and a subsequent intensive reduction in the Earth's rotation speed of the Eocene [6], due to which the compression stresses parallel to the equator arose everywhere with the formation of upslope dislocations of the submeridional strike, and closer to the equatorial zone does of dislocations of the sublatitudinal strike [9]. Let us note that according to [8], the Caledonian fold belt at the time of its formation (400–500 million years ago) also coincided with the equatorial zone (upper inset picture in Figure 1).

Apparently, the modern seismic belts (reflecting the latest folding movements and the subduction episodes) correspond to the similar subequatorial

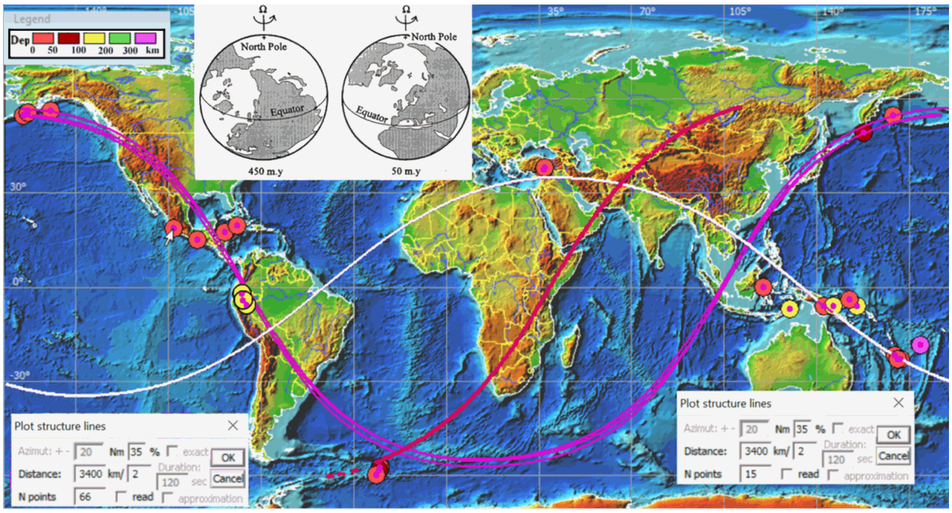

**Figure 1.** The "Main circles" of the Earth corresponding to the Eocene equator (white) and Eocene meridian (lilac), identified by the "Great Circles" algorithm in the GIS-ENDDB environment [11] by seismicity with $M_S \geq 7.5$ for 2017–2023 (the algorithm parameters are in the right inset picture) and for 1973–2023 (the parameters are in the left inset picture). The "Afro-Baikal" seismolineament (red), based on earthquakes with $M_S \geq 6.5$ were also build. The earthquakes with $M_S \geq 7.5$ for 2017–2023 are shown. The top insert picture: the equator position during the laying of the Caledonian (left) and the Alpine (right) fold beats (according to [8]). Map of the GIS-ENDDB program

and submeridional folding belts. Figure 1 shows two seismic "main circles" of the Earth — the equatorial and the meridian one. The term "main circles" was introduced in [10] for two strictly orthogonal Great Circles of the Earth (detected by the GIS-ENDDB seismolineament algorithm), the 10 % (or ≈ 4,000 km) confidence intervals of which cover all global earthquakes with $M_S \geq 7.5$ of the NEIC catalog [12]. Let us note that 37 % of the 219 events with $M_S \geq 7.5$ belong to the equatorial "main circle" (these are mainly earthquakes in the southwestern part of the Pacific seismic belt from the Papua, Fiji and Tonga to the New Zealand and the Southern Ocean, as well as the Alpine-Himalayan seismic belt), 32 % belong to the meridional "main circle" (this is the northern part of the Pacific seismic belt along the subduction zones: Japan-Kuril-Kamchatka, Aleutian, the coast of North and Central America to Ecuador, and in the southern hemisphere: from the Tierra del Fuego and the South Sandwich Islands to the central Indian Ocean) and 31 % belong to the areas of "main circles" intersection (subduction zones of the Chile and the Sunda-Mariana Ring, including the islands of Sumatra, Java in Indonesia and the Philippines). The correct localization of the strongest seismic events of recent times along these "main circles" may reflect the manifestation of tectonic activity associated with modern fluctuations [13] in the Earth's rotation speed.

It should be noted that the Afro-Baikal seismolineament, previously identified by the same algorithm (but for significantly weaker events: with $M_S \geq 6.5$) [11] has a diagonal orientation relative to the "main circles" and is, in comparison with them, a geotectonic structure of lower rank (see Figure 1).

## 2. The construction of possible satellite tangential motion paths at the Cretaceous-Paleogene boundary

So, according to the methodology proposed in [1, 4], the trajectory of the tangential movement of the Perun along the Earth's surface was calculated in accordance with the Eocene position of the equator (also close to the Cretaceous one). The poles for this equator position are located at the following points: 49.93°N; 130.57°W for the North Pole and 49.93°S; 49.42°E for the South Pole.

The result of calculation (Figure 2) shows that the Perun impact on the Earth's surface could be located in a rather limited, narrow corridor corresponding to 10° in both directions from the Cretaceous-Eocene equator. The CB flies strictly in orbit, crossing the equator in a northerly and then in a southerly direction on each turn with a planet shift to the west by 23.25° at the passage of one turn. The route is symmetrical along the equator (see

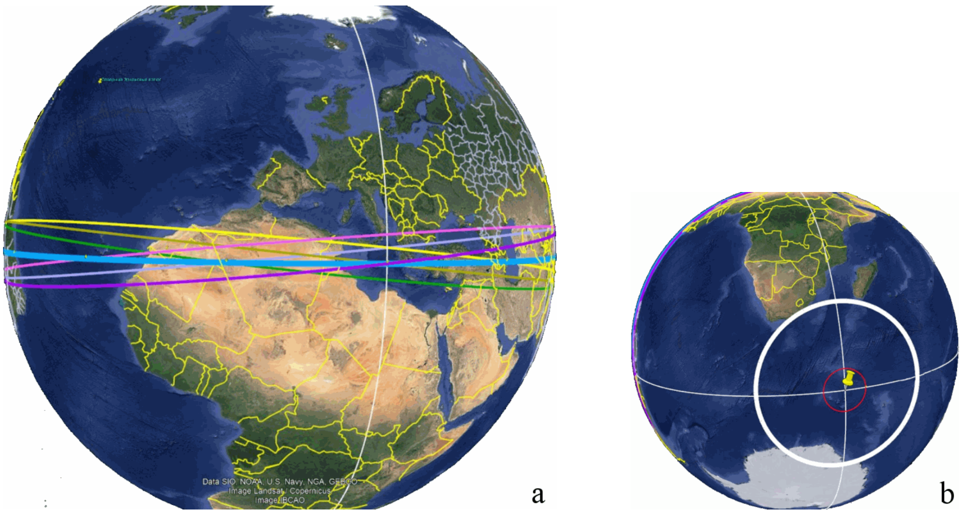


**Figure 2.** The calculated objects location of the K/T boundary in the Google Earth Pro map: a) the equator (blue line), one of the meridians (white line) and 6 turns of tangential motion of the proposed satellite (colored lines); b) the South Pole

Figure 2a), however, the possibility of long-range ejections is also remaining: away from the narrow main line. For example, the well-studied Chicxulub crater confined to the K/T boundary, $D = 180$ km, Mexico (sometimes mentioned along with a second, much larger unknown impact event with a crater diameter $\gg 250$ km [14]) is marked on the gravitational map in composition with other structures of the same to it age (Alvaro Obregn ejection, Ramonal, Albion Island, Belize ejection, Armenia [15]) by a fan-shaped negative anomaly of the SW–NE direction [16] by showing the possible process of disintegrating the large Perun fragment and of the scattering its parts.

The result of tangential motion of the satellite along the main direction and its gradual disintegration could be not only the depression of the Pacific Ocean (having the possible Miocene impact ejecta layers: Ewing and Pelagic [15]), on the site of which (according to [1]) at the Upper Jurassic there was a giant continent of Pacifida (which is also confirmed by recent tomographic data of the GIS-ENDDB program), but also large structures of the relief "smoothing" (Figure 4a) or the Earth's crust "subsidence" under the weight of giant debris (followed by the formation of seas). For example, the calculated routes are according for the following gigantic potential structures of Impact structure catalog [15] that are close in age or have not known age (according to numbering in Figure 3):

1. Zouerath ($D = 1{,}048$ km), Western Sahara / Mauritania;
2. Zouerath 1 ($D = 176$ km), Western Sahara / Mauritania;
3. El-Jabal-el-Garby ($D = 200$ km), Mediterranean;
4. LABMPG-OFA-Antofagasta ($D = 800$ km), Chile, Bolivia, Argentina, Peru;
5. Tyrrhenian Bassin ($D = 400$ km), Italy;
6. Black Sea (possible double impact structure) ($D = 1{,}000$ km);
7. South Caspian sea (Caspian Sea South Basin) ($D = 210$ km), Kazakhstan;
8. Taclamakanskaya (Tarim Basin) ($D = 300$ km), China;
9. Ontong Java Plateau (Pigafetta, East Mariana, Nauru) ($D{=}1{,}200$ km), Micronesians;
10. Priaralaskaya (Aral sea) ($D = 750$ km) and other Kazakhstan giablems [17];
11. Central-Karakumskiy ($D = 220$ km), Turkmenistan;
12. Tore "Seamount" ($D = 122$ km), Atlantic, offshore Portugal.

The satellite images show the other structures characteristic of tangential impact along the flight paths, such as leveled land areas, chains of

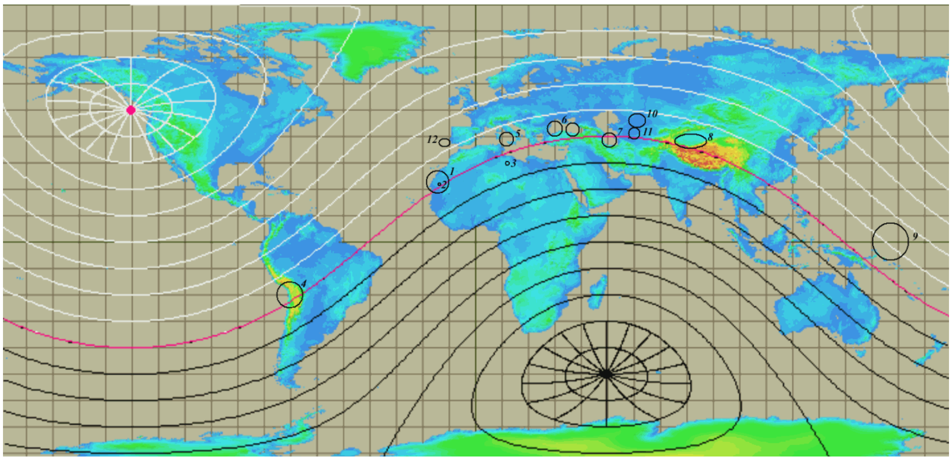

**Figure 3.** The North and South pole of the Cretaceous–Paleogene epoch and the latitude grid in increments of 10°. The largest impact structures listed in the text are plotted along the equator belt (red arc). Map of the Radio Mobile program

trenches and island arcs in the ocean (Figure 4). It is also not surprising that such unique tectonic-magmatic formations as Tibet, Deccan traps, Pamir-Hindu Kush seismic focal zone are located in the immediate vicinity of the described routes. As mentioned above, the Alpine Folded Belt and the Alpine-Himalayan seismicity Belt are also associated with them.

In addition, the new routes are well comparable with maximum anomalies of the summarized $S_V$ field (according to seismotomographic layers below the base of the lithosphere: $225 \leq H < 700$) [18] both with a local anomaly in the west of the central part of the South American continent and with an echelon-like anomaly along the edge of the Eurasian continent [18, Figure 2], representing a chain of deep paleosubduction "channels" of lithospheric material immersion into the mantle.

In conclusion, we can suggest that the other seismic lineaments identified by the GIS-ENDDB algorithm, encircling the Globe around a Great circle of the Earth, may be associated with older (compared to the considered) episodes of folding along the corresponding direction of the meridians or equator at that time.

In particular, the Afro-Baikal seismolineament mentioned above is currently manifested by seismicity of an order of the magnitude lower, and this may indicate a long time ago of the event that laid this structure (Figure 5). However, since a more significant part of this circle passes over land, a larger number of giant astroblemes of the catalog [15] are associated with it, identified by the morphological features in relief and by the gravitational fields and not yet having a time reference:

- Gate South ($D = 800$ km), Argentina, South Offshore,

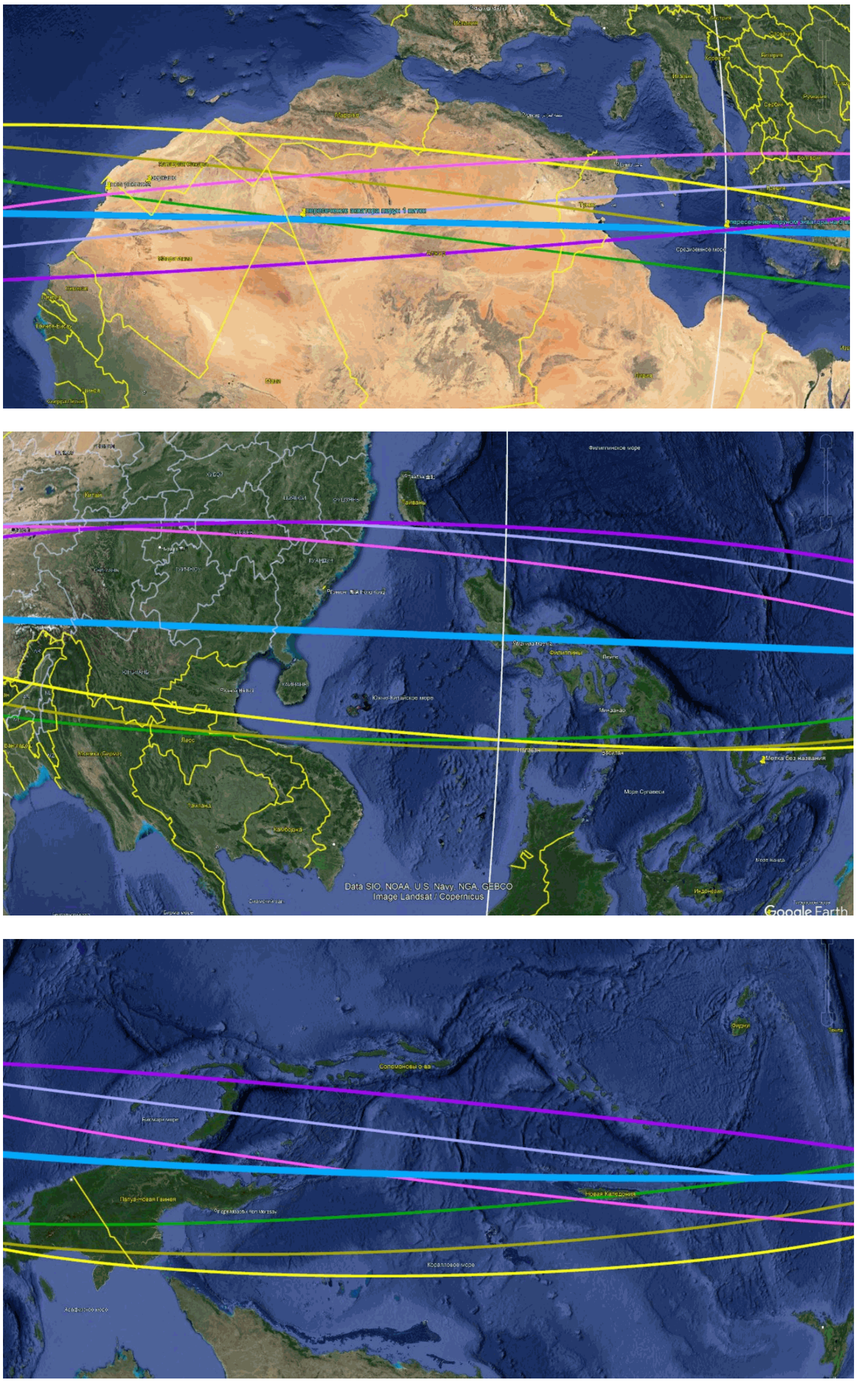


**Figure 4.** The structures of possible tangential impact: a) the Sahara Desert, b) a chain of the seas: the South China, Soul, Celebes, Banda, etc., c) a chain of island arcs of the Coral Sea. Map of the Google Earth Pro program

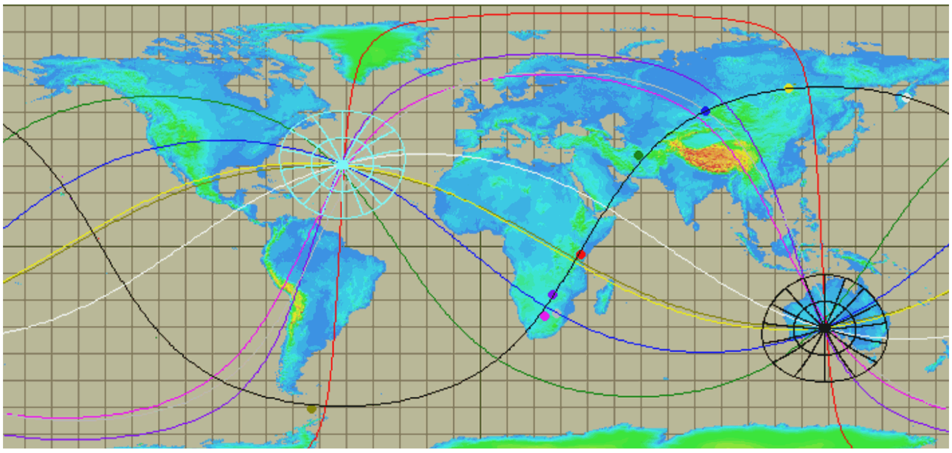

**Figure 5.** The theoretical location of the North and South Poles and the meridional grid of the epoch of folding along the Afro-Baikal seismolineament. The impact structures listed in the text are marked with colored dots along the equator belt (black arc). Map of the Radio Mobile program

- Bushveld-1600 ($D = 1600$ km), South Africa,
- Bushveld-400 ($D = 400$ km), South Africa,
- Bushveld-200 ($D = 200$ km), South Africa,
- LABMPG-OFA-Namibia ($D = 2400$ km), Namibia,
- LABMPG-OFA-Zambia ($D = 1330$ km), Zambia, Zimbabwe, Botswana,
- Kilimanjaro (Tanzanian nuclear, Vostochno-Africanzkaya, Lake Victoria, Lac Victoria, Victoria Njansa) ($D = 800$ km), Tansania, Kenia, Uganda,
- Iran 1 ($D = 260$ km), Iran,
- Iran 2 ($D = 576$ km), Iran,
- Irano-Afganskaya ($D = 4458$ km), Iran-Afganistan,
- Novosibirsky large ($D = 802$ km), Russia, West Siberia,
- Rusinskiy ($D = 858$ km), Russia, Zabaikal'e,
- Kamchatka 1 ($D = 250$ km), Russia,
- Kamchatka 2 ($D = 390$ km), Russia,
- Kamchatka 3 ($D = 400$ km), Russia,
- Kamchatka 4 ($D = 380$ km), Russia.

## Conclusion

In this paper, the previously developed method for calculating the tangent paths of the Earth satellite is applied to the event of the annexation and movement of the Earth satellite Perun along its surface at the Cretaceous-Paleogene boundary, proposed as a hypothesis in the works of L.A. Pukhlyakov. The constructed routes are in good agreement with the position of many geophysical and morphological anomalies indicating the possibility of such an event.

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